Space Weather Technical Forecast

Issued on Wednesday, 06 April 2022 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/G2 Minor to Moderate Geomagnetic Storms likely day 1 and early day 2 (6th and 7th) due to CME arrival. Active high energy electron fluence easing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only a few minor C-class flares, the most notable a long period C3 from over the northwest limb. There are currently six sunspots on the visible disc with the largest AR2978 Chi/beta gradually showing signs of decay, along with AR2981 Cro/Beta. All other regions are small and simple. No Earth-directed CMEs have occurred in the last 24 hours, although there are a number of filaments visible on the Earth-facing disc that are being monitored for any potential lift.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, has been slightly elevated, however speeds have fallen from 450km/s to 400km/s. The solar wind density was at or below average. The interplanetary magnetic field (IMF) strength, Bt, was mostly weak, below 7nT, with the north-south component between -4 and +4nT, but spent much the period in a negative (southward) direction. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES-16 at GEO was at background levels. The high energy (greater than 2MeV) electron flux rose varied between Moderate to High levels, peaking 2903 pfu at 05/1625 UTC. The 24-hour integrated fluence showed a steady rising trend to just above the Active fluence threshold, with an integrated 1.13e8 pfu recorded at 06/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity should be predominantly Low to Very low, with only relatively small and simple sunspot regions currently on the disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun due to a filament eruption around 03/1500 UTC is expected to arrive at Earth in the coming 12 hours, leading to a slightly elevated solar wind environment around Earth, easing day 2 (7th). Otherwise mainly background solar winds are expected until day 4 (9th), with the arrival of the fast wind of coronal hole 72, and a low chance of a glancing interaction from a further CME which left the Sun around 04/2200 UTC, although this is very low confidence. Geomagnetic activity is forecast to become Active to G2/Moderate Storm from the CME arrival later on day 1 (6th) and likely persisting into the first half of day 2 (7th). Quiet, isolated Unsettled conditions then returning, before a further enhancement to Active to G1/Minor Storm is likely day 4 (9th) from the arrival of the CH fast winds.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux is expected to persist at background levels, with only a very slight chance of slight increases from any beyond west limb flares. The high energy (greater than 2 MeV) electron flux is currently diurnally varying between Moderate to High but is expected to drop out with the arrival of the CME later on day 1 (6th). Whilst a recovery in values is possible later in the period, this is likely

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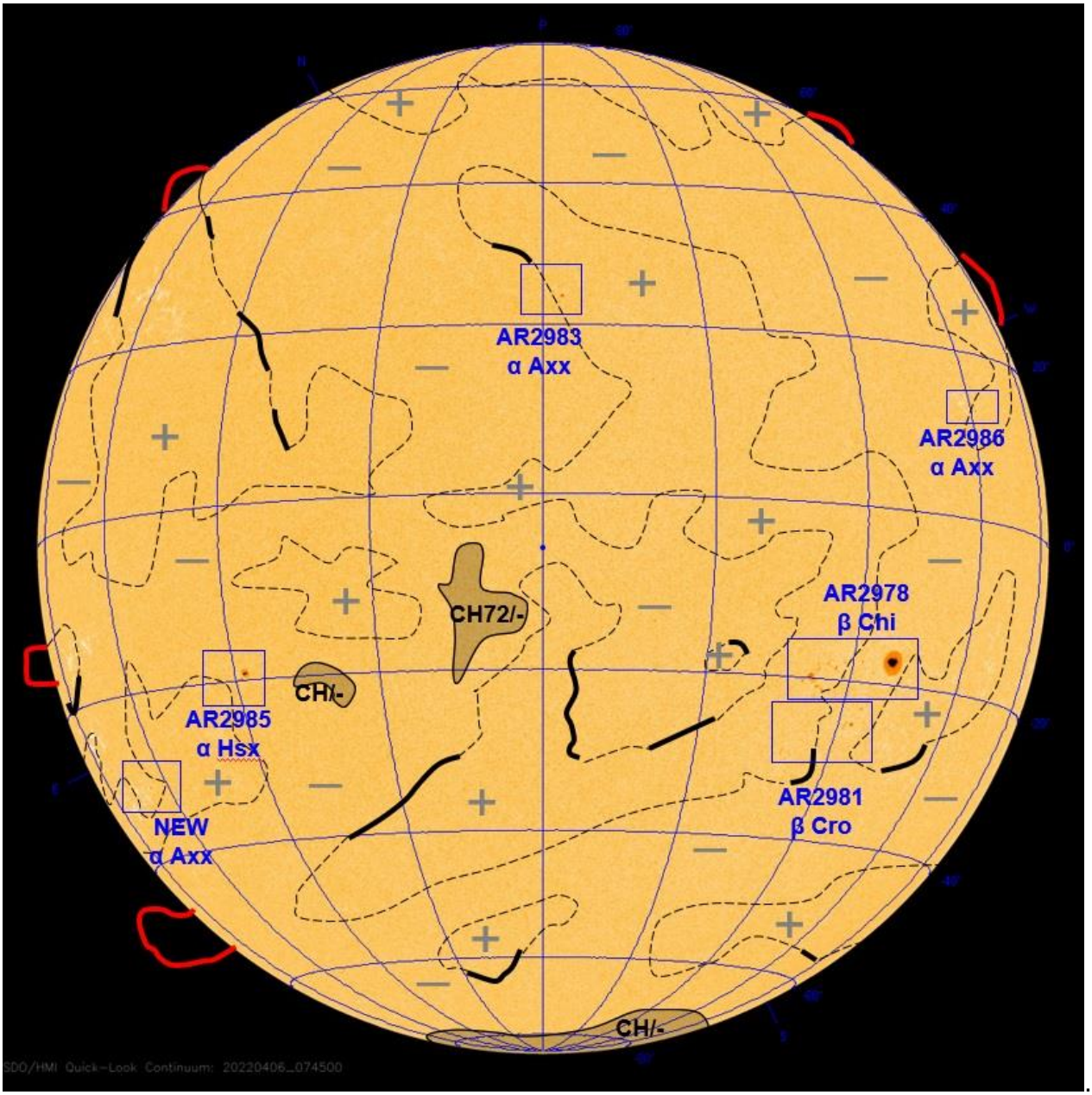
to be to lower levels than currently observed. The associated 24 hour fluence is currently Active, but expected to fall below this level through day 2 (7th) onward due to the drop out in flux.

Figure 1. Solar Analysis Valid 06/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one Earth-directed CME, which is expected to arrive at Earth through the afternoon or evening of day 1 (6th). This is from a filament eruption 03/1500UTC, in the southeast disc. Whilst a limited shock is expected from the arrival, there is the potential for a dense magnetic cloud as the flux rope passes. This will give a likelihood of G1-G2 Minor to Moderate storms, depending upon the polarity and density of the cloud.

A second CME which had been assessed as potentially arriving on day 4 (the 9th) has now been reassessed as likely missing, passing mostly to the south and behind the Earth. There remains significant uncertainty with this analysis however, and a glancing interaction cannot be ruled out on either the 8th or 9th.

Aside from the anticipated CME, solar winds are expected to be at background to slightly elevated, with the next coronal hole enhancement anticipated on day 4 (9th), from the arrival of the fast wind of CH71/-. Along with the slight chance of CME arrival, this will give a chance of further G1/Minor Storm intervals.

Geomagnetic activity is forecast to be Quiet at first, increasing to Active to G2/Moderate Storm from the CME arrival later on day 1 (6th) and likely persisting into the first half of day 2 (7th). Quiet, isolated Unsettled conditions then returning, before a further enhancement to Active to G1/Minor Storm is likely day 4 (9th) from the arrival of the CH fast winds.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	70	60	1	40
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/2240	Halo	Filament Eruption	8W 7S	595 km/s	06/1600 UTC	Estimated arrival time delayed a little. Limited shock expected.

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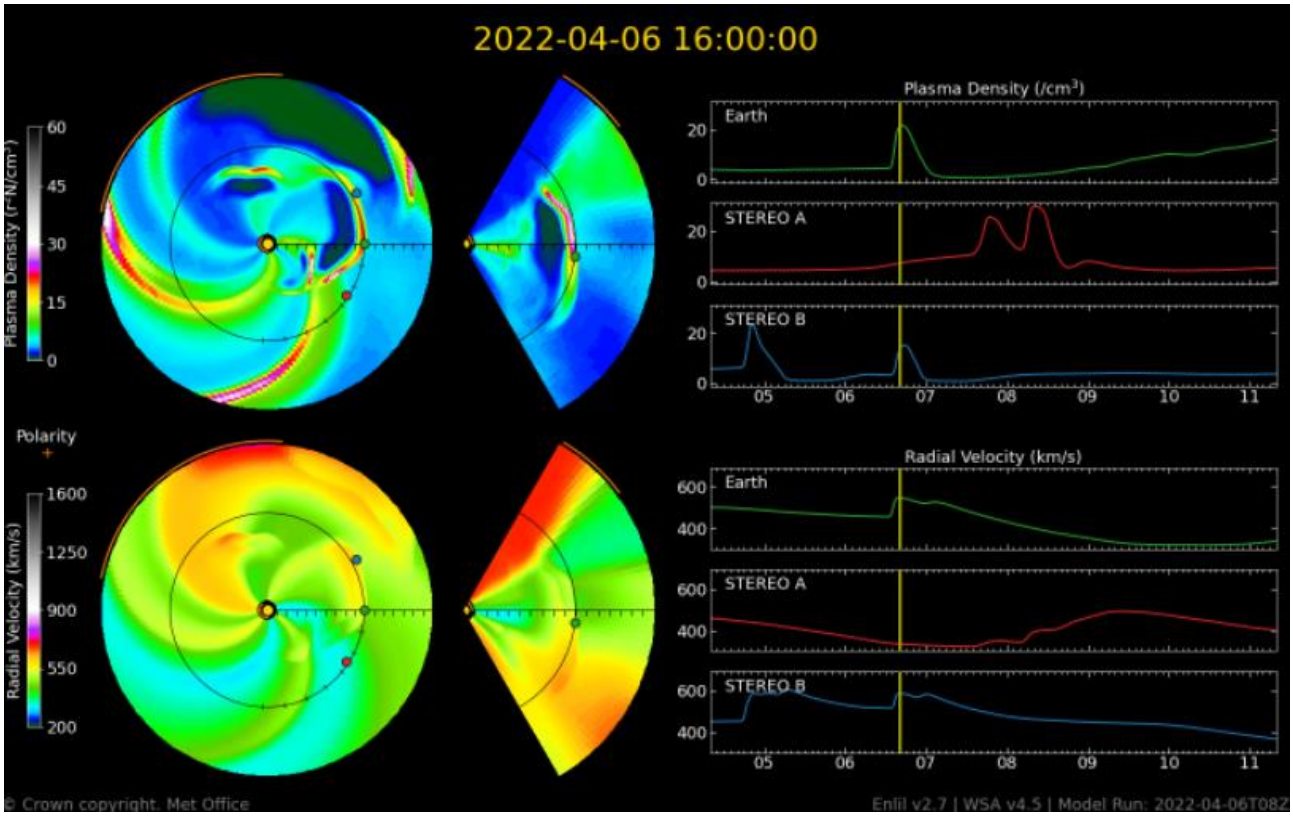
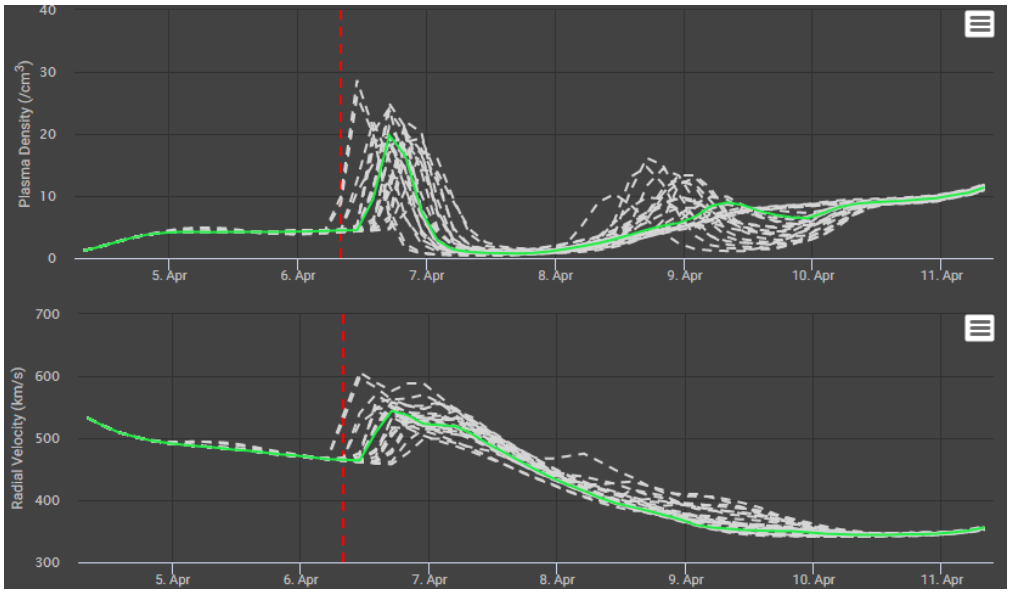
Figure 2: Enlil and ensemble – Late arrival on the 6th, of the first CME. Little sign of 2nd CME on 9th in main run, however ensemble shows slight chance (low confidence) of a glance





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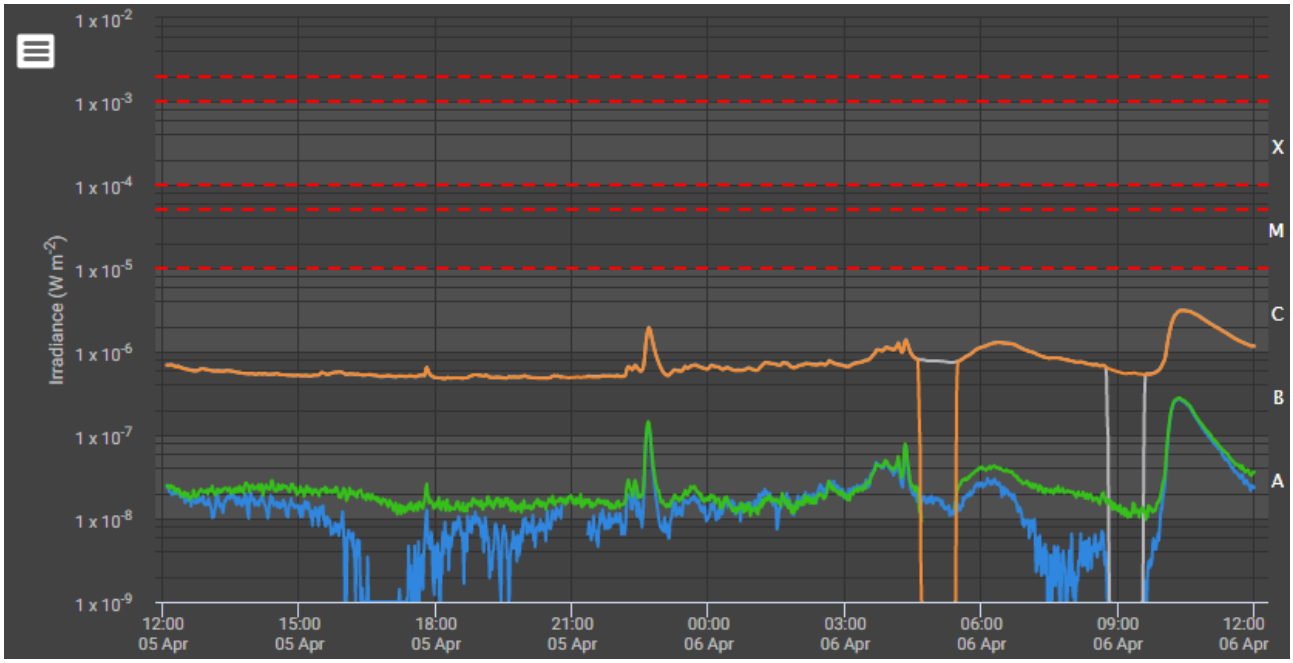
Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with the six sunspot regions on the disc, all relatively small and stable. The largest of these is AR2978 Chi/Beta in the southeast, however this has recently seen its trailer spot decline and has remained inactive as it has traversed across the disc. To the south of this region, AR2981 Cro/Beta has also seen its trailer spot decline, and is now a small and simple spot. All other spots on the Earth-facing disc are smaller and simpler, and unlikely to be the source of notable flares.

Activity is expected to become Low to Very Low, with only a slight chance of rising to Moderate from any M-flares, with the main risk from AR2978

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/17 X-ray Flux



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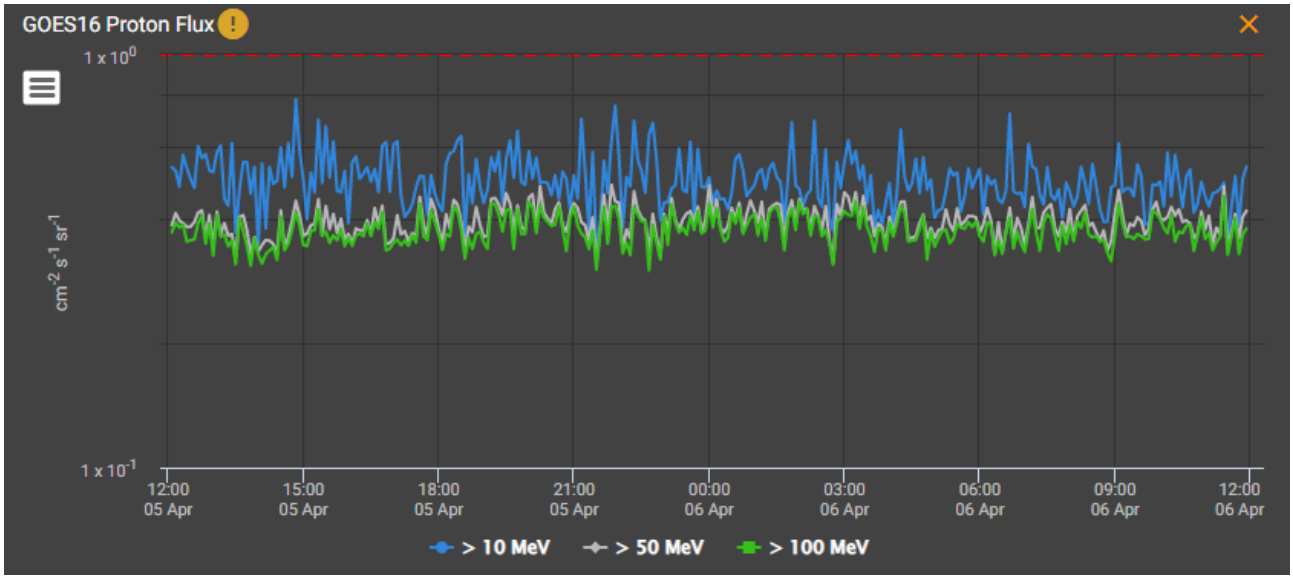
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background levels. Magnetic looping remains visible from the complex of sunspots AR2975 and AR2976 around the limb, and as a known proton source a slight risk of further proton storms is maintained as these rotate away. The other sunspot regions on the disc are small, relatively stable and currently considered unlikely to be a source of proton storms without further development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 Proton Flux At background



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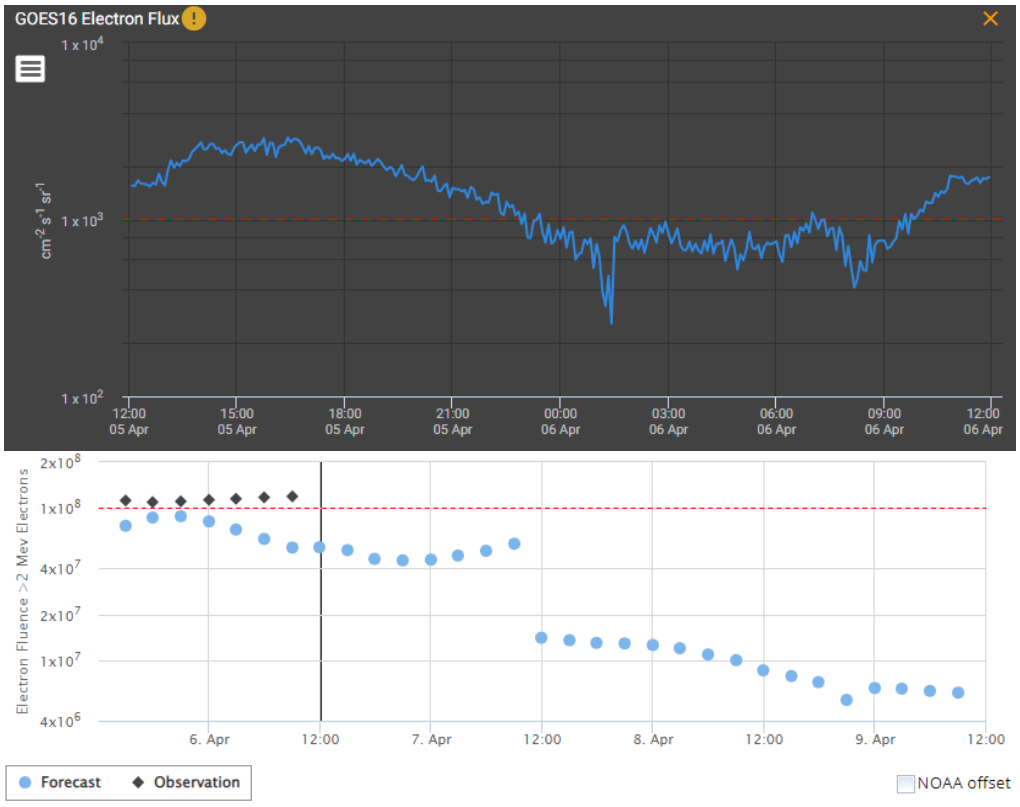
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV), as observed by GOES-16 at GEO varied between Moderate and High levels in the last 24 hours, and in the absence of any other influences would be expected to persist at similar levels through the period. However the arrival of the CME later day 1 (6th) is likely to bring a dropout in values, persisting day 2 (7th), before a recovery to Moderate to high day 3 and day 4 (8th and 9th). The arrival of the fast wind of CH72, and low chance arrival of a further CME on the 9th, is then likely to cause a further drop out of values day 4 (9th).

The associated 24 hour electron fluence is currently Active (above 1e8 pfu), but expected to fall below day 2 (7th) due to any drop out that occurs from the CME arrival day 1 (6th). REFM is currently giving poor guidance, with an expected decrease, despite no knowledge of the anticipated CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES 16 >2MeV Electron Flux and associated fluence with REFM



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